

DRIVE ARRANGEMENT FOR A MOTOR VEHICLE ROOF ELEMENT WHICH CAN  
BE SWIVELED INTO A STOWAGE SPACE IN THE VEHICLE FOR DEPOSITION

Background of the Invention

Field of the Invention

[0001] This invention relates to a drive arrangement for a motor vehicle roof element which can be swiveled into a stowage space for a motor vehicle for deposition, especially for a convertible top.

Description of Related Art

[0002] German Patent DE 195 25 587 C1 discloses a drive arrangement for a convertible top which can be lowered into a rear convertible top compartment by means of a four-bar mechanism, one of the two connecting rods of the four-bar mechanism arrangement being provided on its end which is permanently coupled to the body with a worm wheel which is driven by a worm which is driven by a compressively stiff drive cable in order to cause a swinging motion of the convertible top into or out of the convertible top compartment.

[0003] The disadvantage in this known drive arrangement is the application of force which is constant due to the structure during the swinging process.

### Summary of the Invention

[0004] The primary object of this invention is to devise a drive arrangement in which the application of force during the adjustment process can be made variable with simple means.

[0005] This object is achieved in accordance with the invention by a drive arrangement for a motor vehicle roof with a movable roof part which is connected to a carrier element which can be moved by means of a drive element along a given path of motion, the drive element engaging an intermediate pivot lever which applies the drive force applied by the drive element via a driver to the carrier element depending on the pivot position of the intermediate lever. Furthermore, the drive arrangement is made such that the pivot position of the intermediate lever is determined by the position of the carrier element along the path of motion.

[0006] In this approach according to the invention, it is advantageous that the application of force during the displacement process can be made variable with simple means, especially with few components, in order to increase or decrease the application of force, for example, in the area before reaching the end position.

[0007] The invention is described in detail below with reference to the accompanying drawings.

### Brief Description of the Drawings

[0008] Figure 1 is schematic a side view of the drive arrangement in accordance with a first embodiment of the invention;

[0009] Figure 2 schematically shows a side view of the drive arrangement in accordance with a second embodiment of the invention;

[0010] Figure 3 is a schematic side view of the drive arrangement according to a third embodiment of the invention;

[0011] Figure 4 shows the embodiment of Figure 3 in another position;

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[0012] Figure 5 is a perspective plan view of a motor vehicle with a roof cassette which holds an opened folding roof;

[0013] Figure 6 is a perspective plan view of a motor vehicle with a roof cassette which has been lowered into a stowage space; and

[0014] Figure 7 is a perspective plan view of the motor vehicle with a schematic partial representation of the support of the roof cassette.

#### Detailed Description of the Invention

[0015] Figure 1 schematically shows a drive arrangement for a roof cassette 14 of an openable motor vehicle roof 30 (see Figure 5) according to a first embodiment. The roof cassette 14 is used to hold an openable roof element 31 such as, for example, a folding roof (see Figures 5 & 6) or a louvered roof. Here, the openable roof element 31, which closes the roof opening 32 flat in its closed position, is pushed by means of a drive (not shown) along lateral guides 33 into the roof cassette (14) in order to clear the roof opening 32, this process also being possible when driving. The roof cassette 14 can, for its part, be swung, by means of the drive arrangement described below, for deposition in a rear stowage space 34 of the motor vehicle 35, especially behind the seats, to completely remove the motor vehicle roof 30 in the manner of a convertible. The roof cassette 14 is pivotally mounted on the body via two schematically shown mounting elements 17, 18 which are connected via hinges 3, 4 to two carrier elements 10, 11 which, for their part, are each pivotally supported via a hinge 2, 1 mounted stationary on the body (see Figure 7). The hinges 1, 4; 2, 3 are located on the opposing ends of the carrier elements 11, 10. The carrier element 11 acts as a driven connecting rod. The carrier elements 10, 11 with the hinges 1, 2, 3, 4 form a four-bar mechanism arrangement for a roof cassette 14 by which this roof cassette can be lowered into the stowage space 34. Figure 7 shows the carrier elements 10, 11 and the roof cassette 14 in the intermediate position when the roof cassette 14 is lowered.

[0016] The connecting rod 11 in the lengthwise direction is provided with a guide path 13 into which a driver pin 6 which is made on the intermediate lever 12 fits. The

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intermediate lever 12 on its two ends is provided with a slider 5, 7 which fits into a body-mounted guideway 8, 9 and is guided to slide in it. A compressively stiff drive cable 19 which is driven by a drive which is made in the conventional manner (via a pinion which is driven by an electric motor) engages the slider 5 which lies radially to the outside with respect to the pivot 1 of the connecting rod 11. The radially outside guideway 8 for the slider 5 is made circular in this embodiment. The inner guideway 9 which lies radially inside for the slider 7 runs via wide sections essentially parallel to the outside guideway 8, i.e., it is made likewise circular over significant sections. In the end area 20 of the inner guideway 9, however, its radius is greatly reduced so that the distance between the guideways 8, 9 in this area increases greatly.

[0017] If force is applied to the outer slider 5 in the direction of the arrow from the position shown in Figure 1 by means of the drive cable 19, by engagement of the driver 6 which is located between the two sliders 5, 7 the connecting rod 11 is forced into a pivoting motion clockwise, then the slider 6, 7 being guided in the guideways 8, 9. As long as the distance between the guideways 8, 9 is constant, force is applied to the connecting rod 11 via the driver 6 always at the same location, i.e., at a constant drive force of the drive cable 19 the drive force applied to the connecting rod 11 is likewise constant. In the area of the constant interval the guideways 8, 9 can also be made such that they are on top of one another, i.e., do not have any interval.

[0018] But, if the slider 7 travels into the end area 20 of the inner guideway 9 in which its radius decreases, the distance between the guideways 8, 9 increases and the intermediate lever 12 necessarily executes clockwise rotational pivoting motion, since the slider 7 moves to the inside along the inner guideway 9. In doing so, the driver 6 slides in the guide slot 13 of the connecting rod 11 to the inside, viewed in the radial direction. The rotary motion of the intermediate lever 12 at the same drive speed of the driven slider 5 leads to the pivoting motion of the connecting rod 11 slowing down. Accordingly, with a uniform driving force of the drive cable 19, the drive force applied to the connecting rod 11 for the

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roof cassette 14 increases. Therefore, in the end area 20 of the inner guideway 9, stepping down of the driving motion takes place.

[0019] The drive motion can be stepped up and the drive force reduced by the distance between the two guideways 8, 9 being reduced by, for example, the radius of the inner guideway 9 being increased.

[0020] Basically, it is possible, since for force transfer only the distance between the two guideways 8, 9 is important, instead of the inner guideway 9, to provide the outer guideway 8 with a variable radius. However, since the drive cable runs 19 runs in this outer guideway 8, it is generally preferred that, as shown, the inner guideway 9 is made with a changing radius.

[0021] An increase or decrease of the drive force can be desirable not only in the area of the end position of the roof cassette 14, but under certain circumstances, also in intermediate positions.

[0022] Figure 2 schematically shows a second embodiment of the invention, the essential difference being that, in contrast to the embodiment from Figure 1, the radially inside guideway 9 and the inner slide 7 of the intermediate lever 12, which slide is guided in the latter, are omitted. The dependency of the radial position of the inner end 107 of the intermediate lever 112, i.e., the end nearer the pivot 1 of the connecting rod 111, on the pivot position of the connecting rod 111 is achieved by means of a lock 119 in interplay with a body-mounted stop 118 and a body-mounted sliding cam 117.

[0023] The intermediate lever 112, which is made as a toggle lever, is driven on its radial outside slider 5 by a compressively stiff drive cable 19 in a body-mounted circular guideway 8 which has the rotary axis 1 of the connecting rod 111 as the center point. The force is applied to the connecting rod 111 as in the aforementioned embodiment by means of a driver 6 which is made on the intermediate lever 112 and which fits into a guideway 113 which is made in the connecting rod 111 essentially in the radial direction.

[0024] The lock 119 can be moved in the connecting rod 111 in an essentially tangential direction, its being pre-tensioned by means of a compression spring 116 into a

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position (see Figure 2) in which it forms a contact surface 120 for the inner end 107 of the pivot lever 112 in the radial direction. In this way, in the position of the connecting rod 111 shown in Figure 2, the radially inner end 107 of the intermediate lever 112 is prevented from moving in the radial direction to the inside; together with the engagement of the driver 6 in the guideway 113, this provides for fixing of the intermediate lever 112 relative to the connecting rod 111. In this position, thus, at a constant drive speed and drive force, the connecting rod 111 moves with a constant speed and constant force via the drive cable 19 and the outer slider 5. In the embodiment of Figure 1, this state corresponds to the area in which the two guideways 8, 9 run with a constant distance between them, i.e., concentrically.

**[0025]** The sliding cam 117 and the stop 118 lie in different planes, the stop 118 being located such that with the corresponding angular position of the connecting rod 111, the lock 119 with its front end 121 runs against the stop 118 and then is pushed back accordingly against the pre-tensioning force of the compression spring 116 in the tangential direction. In this way, the contact of the radially inside end 107 of the intermediate lever 112 with the contact surface 120 of the lock 119 which points radially to the outside is ended, by which the end 107 is released. The sliding cam or the sliding cam element 117 is made such that, after the lock 119 is pushed back by the stop 118, the radially inside end 107 of the intermediate lever 112 makes contact with the contact surface 122 of the sliding cam element 117, by which the radial position of the inner end 107 of the intermediate lever 112 is now determined by the shape of the contact surface 122. It is shaped as shown in Figure 2 such that the inner end 107 of the intermediate lever 112, as the pivoting motion of the connecting rod 111 continues around the axis 1 of rotation in the direction of the arrow, i.e., clockwise, can move radially to the inside; in interaction with the guide of the driver 6 in the guide slot 113 of the connecting rod 111 and the continued constant application of force to the slider 5 leads to a rotational pivoting motion of the intermediate lever 112 clockwise. The shape of the contact surface 122 of the sliding cam element 117 corresponds to the shape of the inner guideway 9 from Figure 1 in its end area 20.

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**[0026]** The rotational pivoting motion of the intermediate lever 112 achieved thereby, in the embodiment as shown in Figure 2, has the same effects as in the embodiment as shown in Figure 1, i.e., the pivoting motion of the guide rod 111 slows down while the force accordingly increases so that stepping-down of the drive motion of the connecting rod 111 takes place in the end region of the pivoting area.

**[0027]** One advantage of the embodiment as shown in Figure 2 is that the inner guideway of the embodiment as shown in Figure 1 can be omitted for the most part, i.e., with the exception of the sliding cam element 117; this can lead to advantages in terms of construction space and/or costs.

**[0028]** Even if the invention so far has been described with reference to a drive provided with a drive cable, the application of the driving force to the intermediate lever 12, 112 is fundamentally possible in a different manner, for example, by means of a drive rod.

**[0029]** This invention is not limited to the drive of a connecting rod, i.e., a lever which is pivotally coupled to the body on one end, but the adjustable roof parts can in general be driven along a given path of motion, as is shown in Figures 3, 4 for a slider plate 225 as the driven roof part to which, for example, the roof tip of a folding roof guided on roof-mounted guides is attached.

**[0030]** The slider plate 225 is guided by a guide means which is not shown along a body-mounted guideway, for example a guide rail, on a stipulated path 219 of motion. This example is a linear section; the path of motion or the guide rail 219 could also be curved if necessary.

**[0031]** The slider plate 225 can also be, for example, a driven element of the roof mechanism for a folding roof, a convertible top, a sliding roof, a sliding and lifting roof, a louvered roof or a spoiler roof.

**[0032]** A compressively-stiff drive cable (not shown) which is driven preferably via a pinion by the electric motor runs in a cable channel 228 and is rigidly connected to a slider 220 which is guided in the cable channel 228 and is connected via a hinge 222 to one end of an intermediate lever which is made as a toggle lever 221. The other end of the toggle

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and the distance  $a$  between the driver 224 and the hinge 223, and on the other hand, by the configuration of the curved section 227 of the guide channel 229, and can be adjusted accordingly via these parameters for the respective application.

[0037] The application of a driving force to the slider plate 225 depends on the pivot position of the toggle lever 221 which, in turn, depends on the position of the slider plate 225 along its path of motion. In this way, application of the driving force which is variable as necessary is enabled.

[0038] Instead of being determined by means of engagement of the slider 230 in the guide channel 229, the pivot position of the toggle lever 221 can also be determined, as in the embodiment shown in Figure 2, by a lock element which is actuated, for example, by a stop depending on the position of the slider plate 225, and which, in the unactuated state, forms a contact surface for the guide point of the toggle lever 221 which corresponds to the slider 230. In this modification, the guide channel 229 can be completely eliminated at least with respect to its straight section, and the curved section can be replaced by a curved contact surface, as in Figure 2.

[0039] In principle, this invention enables any adjustable, variable application and step-up/step-down of the drive force with a reliable mechanical embodiment and with low construction space requirement.

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